

Continuing Education and the History of Science¹

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August 1993

Abstract

Continuing education, and especially the general continuing education of non-specialists, is a valuable context for the teaching of the history of science. The subject can be presented in illuminating and appealing ways in relation to other aspects of culture such as technology, religion and literature. However, the science/technology and science/religion demarcations continue to be problematic and controversial, particularly for the general public. The issues that arise can be well illustrated by reference to the history of science in the 9th and 19th centuries.

Teaching the history of science

The teaching of the history of science embraces at least four different categories of work, i.e.

1. The history of a particular scientific discipline, taught to students who are specialising in it.
2. "Broad brush" history of science, taught to mixed groups of university students who are not necessarily scientists.
3. "Open" courses of continuing education for the public in general who are not necessarily seeking an academic qualification of any kind.
4. The use of history in science teaching in schools.

These categories depend to some extent on the funding and structure of higher education in different parts of the world, and take different forms in different institutions. For example, the University of Southampton has a dedicated department, the Department of Adult Continuing Education, providing courses of type (3) in all disciplines for students of all ages.

However, the system of higher education is now changing very quickly. In Britain there is a growth in the number of part-time students at all levels, modularisation is leading to greater flexibility and choice on the part of the student, and credit transfer between institutions is being

¹ Based on a paper presented originally at the XIXth International Congress of History of Science, Zaragoza, August 1993.

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facilitated so that courses provided in one institution can theoretically be taken by students who will graduate from another. Moreover, the system of government funding for continuing education is being altered radically so as to encourage all students to pursue courses leading to standardised academic awards (certificates, diplomas or degrees). One effect of all these changes is to bring about a convergence of the categories (2) and (3) above, with new opportunities to promote the teaching of the history of science in the continuing education context.

Continuing education is in many ways a natural arena for the teaching of the history of science. The history of science, like any interdisciplinary subject, can benefit considerably from the maturity and expertise that older students bring to it. Theoretically, the history of science can be regarded as the story of the collective continuing education of our species. In practice, teaching the public about the history, meaning and significance of science has always been an important function of university departments of continuing education.

The scientist who works in this field is inevitably confronted by questions of historiography and epistemology which are discussed below. Although not new questions, they seem to assume a special significance in relation to continuing education and to lead, if not to solutions, then to discussions of perennial public interest. It is in this spirit, of identifying some interesting questions rather than answers, that this paper is presented.

Can we learn about science from its history?

Why should we teach the history of science? Courses are often justified on the grounds that they give non-scientists an insight into the nature of science. It is as though, to convey the meaning and significance of science, the history of science is utilised as a sort of substitute for teaching the science itself in depth. If it is impractical to teach an understanding of science itself to everybody, can its history serve equally well for the purpose of popularisation?

Arguably the history of science is no less complex than science itself, and science in the past was not intrinsically easier than science today, but many ordinary people approach the history of science in that belief and, indeed, *because of* that belief. And experience shows that, if our objective is to popularise science, then the history of science certainly provides material which is accessible, interesting, and entertaining to the community at large.

But are we then missing something? General presentations of the history of science often concentrate on the pre-20th-century period and pay little attention to the recent decades over which science has changed at such an unprecedented rate. Are our students in danger of being misled by the conventional focus of the history of science? Is there, even, a sense in which the classic "modern" science of 1492-1942 was essentially different from that of, say, 1950-2000? Just as some historians claim modern science to be qualitatively different from medieval science, to the point of even denying the existence of medieval "science", could it be said that science has undergone a similarly radical change in our own lifetimes, unnoticed by historians? History may be a delightful guide to today's science, but is it a reliable one?

Can science be popularised at all?

A related question was expressed concisely by Steven Shapin in a recent essay, *Science and the Public*³: "are all attempts to 'popularise' science doomed to failure or fraud?" "Fraud", perhaps, because it can be argued that our narratives, metaphors and analogies about science are ultimately betrayals, because one never really understands science without doing some of it at a serious level. It is sometimes said that science is all about processes of thinking and communicating, and can only be comprehended experientially. In this connection it is noteworthy that insights from the history of science are being used to valuable effect in schools to enable children to experience scientific thinking in exploratory and creative ways that reflect how science actually works⁴.

Shapin's question about the possibility of popularisation is linked to another question, that of the inevitability of the cultural gap that appears to separate science from other aspects of human culture. Shapin, in the essay referred to, seems to claim that the cultural gap is not inevitable and that in the past "such a cultural gulf was not a 'natural' or inevitable feature of the place of science in the overall map of culture". He mentions the programme led from the 17th century by Francis Bacon and Robert Boyle which emphasised useful technology as the product of science, and which "vigorously insisted upon the necessity of a public presence in proper scientific practice". And by the 19th century, the public in the United Kingdom was being persuaded that science must be supported for the public economic good, and for no other reason. All the ideological pressure went towards understating the demarcation between science and practical technology, and therefore between science and everyday culture.

Science vs. technology

So, a Baconian philosophy of science seems to go hand in hand with a belief that true science cannot and should not be separated from general culture by any unbridgeable gap. Baconians must be popularisers. But conversely, are popularisers inevitably Baconians? And what should the historian say to the public about the demarcation between science and technology?

This demarcation raises important issues and has a number of different facets. There is of course the purely historical issue of whether the evidence of the past tells us that science and technology, in their essence, should be considered as distinct cultural entities, just as one finds a clear distinction between, say, medicine and religion. I would suggest that the answer is yes.

³ Shapin, S., *Science and the Public*, in Olby, R.C. et al. (Eds.), *Companion to the History of Modern Science*, Routledge, London, 1990, pp. 990 et seq.

⁴ See for example Elspeth Crawford, *The Trojan Horse: how to use and maintain teaching history of science within a science curriculum*, contribution to this conference.

Then there is the question of a historiographic demarcation: and Peter Milner has pleaded for the histories of science and of technology to be clearly distinguished from one another at least for the sake of the historians of technology⁵.

But in the context of education, and particularly continuing education, the question takes the form of whether science should be presented as merely the handmaiden of technology. Does science have a purpose different from that of technology? It is a topical ideological question. Today in Britain, as elsewhere, there are powerful political forces that see little or no value in science except insofar as it might bear technological fruit of economic use. To mention just one example: Sir Walter Bodmer, in his 1988 Presidential Address to the British Association for the Advancement of Science, stressed to the extreme the need "to promote science and technology for the good of the nation..." and to harness science "for the maximum benefit of productivity and potential benefits...." Such rhetoric could have been plucked from the 19th century, and is familiar to historians who have examined the process by which the utilitarian attitude to science was successfully promulgated at that time, as alluded to above; it was a process in which members of the newly-founded British Association played a prominent part. Evidently the history is inextricable from current scientific politics.

In making these comments, it is not my point that Sir Walter Bodmer is incorrect or that Baconianism is discredited. The point is simply that some of the most influential voices in the movement for promoting the public understanding of science belong to those who are deeply committed to a particular model of the relationship between science and technology.

This is not a trivial or merely abstract point. In Britain it is assuming importance because of some of the developments in higher education that were referred to at the start of this paper. The funding system that sustains continuing education in science, and particularly the public understanding of science, is changing. Benign academic neutrality is giving way to the involvement of agencies and institutions who are themselves players in the game. One example will suffice to make the point: in Britain, as traditional sources of educational funding wither, the Cabinet's Office of Science and Technology has begun to offer financial support to promote Government objectives in relation to the wider public understanding of science. Those objectives are unashamedly utilitarian and economic, and applicants are urged to seek matching support from industrial sponsors who will, of course, have their own agendas in relation to the public appreciation of industry. Although such support is very welcome, it increases the tendency for those who teach and research on the character of science to be pushed, for financial reasons, into adopting a particular prior position about what that character is.

Science vs. religion

Not that there is anything new about the problem of demarcation between science and technology, or about contemporary ideology influencing the construction of the history and philosophy of science. Indeed, it is arguable that the philosophy of science has always revealed more about the ideological *milieu* of the philosophers than it ever has about science!

⁵ Peter Milner, *Systems, Problems and Technological Activities: Towards an Internalist Structure for the History of Technology*, contribution to this conference.

The history of science can shed a good deal of light on the science/technology demarcation problem, and also on the other notoriously problematic demarcation, that between science and religion. From this point of view many teachers have found it especially fruitful to focus on the late 18th century and the 19th century.

For example, Jean Dhombres recently drew attention to how François René de Chateaubriand, in French Revolutionary times, complained about science because he objected to what seemed to follow from it technologically⁶. In England, a little later, William Blake was taking a broadly similar line, inveighing against technology-oriented science with a passion expressed in the often-quoted lines from *Jerusalem*:

I turn my eyes to the Schools and Universities of Europe
And there behold the Loom of Locke, whose Woof rages dire,
Wash'd by the Water-wheels of Newton: black the cloth
In heavy wreathes folds over every Nation: cruel Works
Of many Wheels I view, wheel without wheel, with cogs tyrannic
Moving by compulsion each other, not as those in Eden, which,
Wheel within Wheel, in freedom revolve in harmony & peace.

Chateaubriand and Blake were forerunners of the Romantic movement in France and England. The Romantics were not generally opposed to science *per se*, but to what they regarded as its subversion and misuse. Their thinking was quite compatible with the use of science in relation to natural theology: Blake's *Tyger* immediately springs to mind, and there was a vast literature based on the application of science to theology and philosophy. In England, the *Bridgewater Treatises* were perhaps the most prominent manifestation of this movement in the mid-19th century. In effect, Chateaubriand and Blake were reacting against the construction of a demarcation between religion and science and the placing of science in the service of technology. Science was ceasing to be epistemologically and philosophically linked with religion, notwithstanding the persistence of natural theology. Instead, personified by Blake as Newton and Locke, science could be seen as positively irreligious.

Historians often rightly emphasise the differences between, on the one hand, 19th-century natural theology, and on the other hand the burgeoning Darwinian movement with all its anti-biblical and atheistic associations. Nevertheless in one respect the Darwinians and the natural theologians were of one mind: following Blake and Chateaubriand in refusing to separate scientific fact from questions of value and morality, they drew moral and social lessons from the science of the natural world. The opposing camp, from this point of view, was that of the technologists by whom the facts revealed by science were seen as having no transcendent value but as mere commodities to be exploited industrially for economic gain.

⁶ J. Dhombres, *Science and Anti-Science, an Old Story*, Impact of Science on Society, 151, pp. 209-217.

The separation of fact from value, and the commercialisation of science, are close ideological relatives of the idea that science and religion are separate and incommensurable. The demarcation of science from religion was persuasively urged by many scientists and theologians in the 19th century. It was argued by those scientists who happened to be atheists, as one would expect; and it was argued also by churchmen who resisted the imperialism of science, perhaps fearing the consequences of subjecting biblical knowledge to "scientific" standards of proof. John Henry Newman, in his *Idea of a University*, was forceful in his view that "theology and science, ... are incommunicable, incapable of collision, and needing, at most to be connected, never to be reconciled"⁷.

Meanwhile, the separation of science not from religion in general but from Christianity in particular was being argued by the extreme Darwinians such as Haeckel who were actually making a new non-Christian religion out of Darwin's science. So it was that by the second half of the 19th century there were few people to be found anywhere to challenge the notion that science and Christianity are alien to one another.

The literature of the time makes this subject especially accessible and appealing and can help to clarify the complex ideological shifts that were going on. For example, the verse of Gerard Manley Hopkins expressed a commonly-felt despair at the meaningless universe revealed to religionless science⁸:

We see the glories of the earth
But not the hand that wrought them all:
Night to a myriad worlds gives birth,
Yet like a lighted empty hall
Where stands no host at door or hearth
Vacant creation's lamps appal.

...

And still th'abysses infinite
Surround the peak from which we gaze.
Deep calls to deep, and blackest night
Giddies the soul with blinding daze
That dares to cast its searching sight
On being's dread and vacant maze.

⁷ John Henry Newman, *The Idea of a University*, Ian Ker (Ed.), Clarendon Press, Oxford, 1976.

⁸ Gerard Manley Hopkins, *Nondum*, 1866, in *Poems and Prose*, Penguin, 1953.

But elsewhere he was optimistic, putting across a particularly vivid perception of divine meaning in nature⁹:

As kingfishers catch fire, dragonflies draw flame;
As tumbled over rim in roundy wells
Stones ring; like each tucked string tells, each hung bell's
Bow swung finds tongue to fling out broad its name;
Each mortal thing does one thing and the same:
Deals out that being indoors each one dwells;
Selves - goes itself; *myself* it speaks and spells,
Crying *What I do is me: for that I came.*

This draws attention to a deep and ancient problem which, it can be claimed, lies at the heart of the modern problem of demarcation between science and religion and has been a powerful undercurrent to the relationship between science and technology. It is the problem of dualism.

Against dualism

Dualism is the belief that the universe has two distinct parts, the natural and the supernatural; in other terms the sublunar and the etherial, or the earthly and the divine. The opposition of the intrinsically evil to the intrinsically good is the Manichaeian dualism with which Augustine wrestled. Dualism has been a recurrent theme throughout the history of cosmology and science. It has not always been a negative influence: nobody can deny that the dual Aristotelian universe was a successful and durable model; and it can be claimed that the Platonic dualism of forms beyond reality, abstraction beyond actuality, is the quintessence (no pun intended) of modern scientific thinking. But the dualism that separates nature from a hypothetical supernature has allowed the worst of superstitions to flourish.

While dualism has been a recurrent theme throughout the history of science, meanwhile anti-dualistic ideas, i.e. the various attempts that have been made to resist dualistic thinking, have been seminal to scientific advance and especially to the recurrent Kuhnian-like revolutions that have punctuated the history of science. This was conspicuously the case with Copernicanism and with Darwinism. In the teaching of the history of science it is therefore useful to give particular attention to those periods when dualism was being most forcefully challenged.

The last-quoted piece above, by Hopkins, was influenced by a rediscovered Scotism based on the ideas of the 13th/14th century theologian Duns Scotus. However, the best example of anti-dualistic thinking is probably that of the earlier writer who, being a "Scot" in the terms of the time, is sometimes confused with Duns Scotus: the 9th-century Irish theologian/cosmologist John Eriugena. John Eriugena worked at the court of Charles the Bald, in what is now France. He has generally been neglected and undervalued by historians of science, but there is a growing

⁹ Gerard Manley Hopkins, 1877, op. cit.

body of literature about him.¹⁰ Eriugena's most important work, the *Periphyseon*, is now available in a new edition in English.¹¹

Eriugena is a challenging and surprising figure not only because of his achievements in their own context but also because he forces the historian of science to reexamine a number of myths about medieval science. He was an uncompromising opponent of dualism in its various forms. At the start of his career, embroiled in the then-current theological controversy over divine predestination, he argued that God created time and therefore transcends it. Later, he taught that because space is created, God is beyond space as well as time. Eriugena therefore rejected the concept of a physically-located Heaven. Heaven and Hell are not places: we live in a unitary cosmos and there is no "supernature". We should not look for God beyond the edge of our universe, but in the ordinary workings of nature and in our own thoughts and actions.

Eriugena did not consider that science and theology are about different regions of the universe, and he believed that human reason should be applied equally to both. He wrote that "true philosophy is true religion, and, conversely, true religion is true philosophy"¹², meaning that real Christianity should be rational and that rationalism is a form of Godliness. In rejecting the idea of a demarcation between science and religion, Eriugena's views are in sharp contrast to those of the 19th-century theologian, Newman, quoted earlier in this paper.

Eriugena developed a sophisticated and ingenious rational cosmology, including a quasi-Copernican theory of the large-scale universe. Again, he challenges preconceptions about medieval science. In one sense he was not a "scientist" because his cosmology was based neither on mathematics nor on personal experiment or observation, but on the other hand he was an uncompromising rationalist. And if the historians are right who say that the public significance of the Copernican revolution was philosophical and "cosmological" in the broad public sense, rather than in the mathematics, then it was Eriugena's revolution too. The 9th century, then, is more fruitful and raises more questions for the historian of science than might have been imagined. With John Eriugena we are brought face-to-face with the fundamental problem of dualism and with the particular question of a science/religion demarcation.

Summary

The purpose of this paper has been to point out the different contexts in which we have occasion to teach the history of science and to discuss some general questions that seem to assume special prominence in the context of continuing education or public education. To understand the history of science it is crucial to understand something of the relationships between science, technology and religion; but the demarcations between them have always been problematic and controversial and remain so today.

¹⁰ O'Meara, J.J., *Eriugena*, Oxford University Press, 1988, and references therein; and Counihan, M.J., *Ireland and the Scientific Tradition*, Ch. 1 of *The Creative Migrant*, O'Sullivan, P. (Ed.), Leicester University Press, 1994.

¹¹ John Eriugena, *Periphyseon*, O'Meara, J.J. (trans.), Bellarmin, Montreal, 1987.

¹² John Eriugena, *De Praedestinatione*, quoted in O'Meara, *Eriugena*, op. cit., p. 28.

By looking at the 9th-century work of John Eriugena not only can we start to redress historians' general neglect of him and his period, but we can bring out the problem of the science/religion demarcation with unusual clarity and see its roots in the history of dualism in general. By the 19th century the situation had become more complicated because of the rise of technology, because of the confusion of different philosophies that were prevalent, and because of the complexity of the cultural and social reactions at the time; but the 19th century repays study especially by helping to explain many of the popular attitudes to science that are persisting today and are still so frequently encountered in public continuing education.